



# GRAIL

## Gravity Recovery And Interior Laboratory

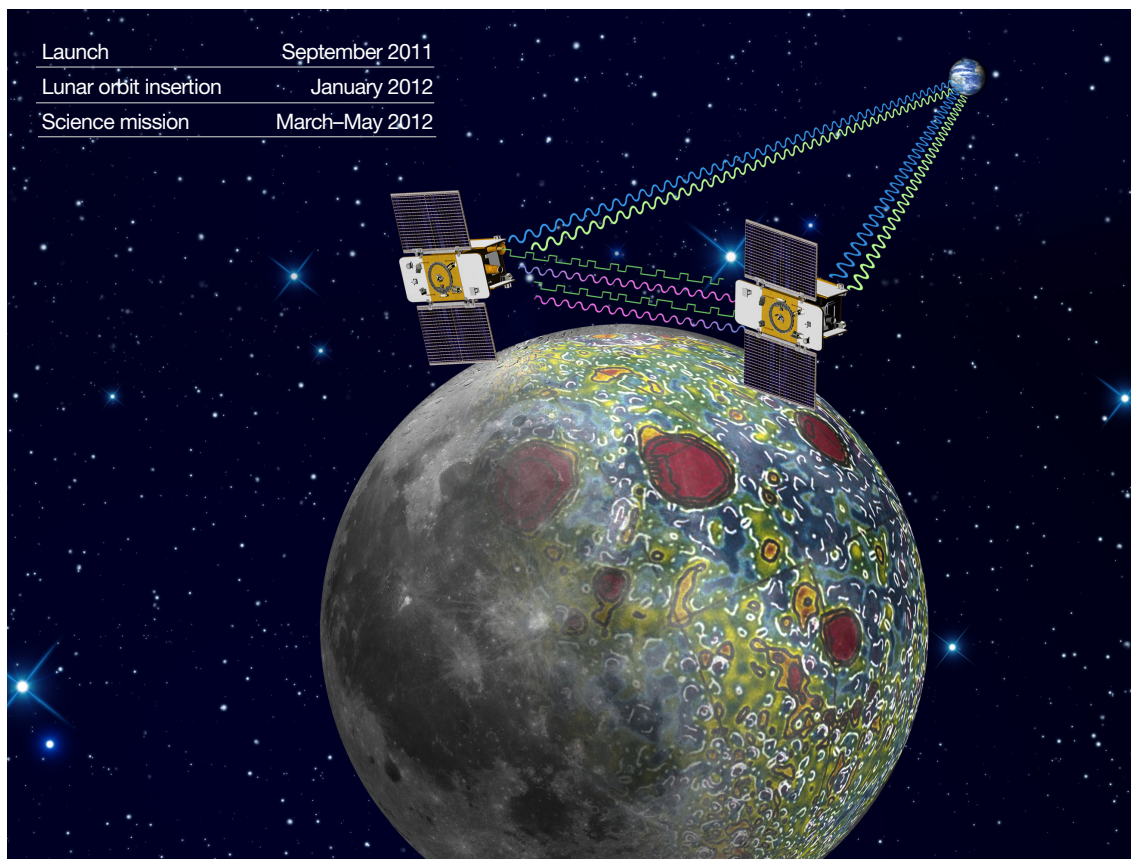
The Gravity Recovery And Interior Laboratory (GRAIL) mission will create the most accurate gravitational map of the Moon to date, improving our knowledge of near-side gravity by 100 times and of far-side gravity by 1000 times. The high-resolution gravitational field, especially when combined with a comparable-resolution topographical field, will enable scientists to deduce the Moon's interior structure and composition, and to gain insights into its thermal evolution — that is, the history of the Moon's heating and cooling, which opens the door to understanding its origin and development. Accurate knowledge of the gravity will also be an invaluable navigational aid to future lunar spacecraft. Ultimately, the information contributed by the GRAIL mission will increase our knowledge of how Earth and its

rocky neighbors in the inner solar system developed into the diverse worlds we see today.

### Science Team and Mission Partners

The GRAIL Principal Investigator (PI) is Professor Maria Zuber of the Massachusetts Institute of Technology (MIT), the Deputy PI is David Smith (MIT), the Project Scientist is Michael Watkins of the Jet Propulsion Laboratory (JPL), and the Deputy Project Scientist is Sami Asmar (JPL). The Project Manager is David Lehman (JPL) and the Deputy Project Manager is Tom Hoffman (JPL). Additional partners include Lockheed Martin, Goddard Space Flight Center, and Sally Ride Science. GRAIL is a mission in NASA's Discovery Program of solar system investigations.

# NASAfacts



## Mission Highlights

GRAIL's twin spacecraft will orbit the Moon in formation, precisely measuring how the distance between the two spacecraft changes. The lunar mass distribution causes variations in spacecraft separation. The spacecraft will fly at a nominal altitude of 50 kilometers and average separation of 200 kilometers.

## Engineering Objectives

GRAIL's engineering objectives are to enable the science objectives of mapping lunar gravity and using that information to increase understanding of the Moon's interior and thermal history. Getting the two spacecraft where they need to be, when they need to be there, requires an extremely challenging set of maneuvers never before carried out in solar system exploration missions.

## Mission Design

The two GRAIL spacecraft will be launched together and then will fly similar but separate trajectories to the Moon after separation from the launch vehicle, taking about 3 to 4 months to get there. They will spend about 2 months reshaping and merging their orbits until one spacecraft is following the other in the same low-altitude, near-circular, near-polar orbit, and they begin formation-flying. The next 82 days will constitute the science phase, during which the spacecraft will map the Moon's gravitational field.

## Spacecraft and Payload

The two GRAIL spacecraft are near-twins, each about the size of a washing machine, with minor differences resulting from the need for one specific spacecraft (GRAIL-A) to follow the other (GRAIL-B) as they circle the Moon. The science payload on each spacecraft is the Lunar Gravity Ranging System, which will measure changes in the distance between the two spacecraft down to a few microns — about the diameter of a red blood cell. Each spacecraft will also carry a set of cameras for MoonKAM, marking the first time a NASA planetary mission has carried instruments expressly for an education and public outreach project.



*GRAIL will improve our knowledge of the Moon's near-side gravity by 100 times.*

## MoonKAM

While the two GRAIL spacecraft perform their gravitational experiment, they will also serve as eyes on the Moon for Earth's students. MoonKAM, which stands for Moon Knowledge Acquired by Middle school students, is an exciting program for middle-school kids, led by Sally Ride Science. What would you photograph if you were flying around the Moon? Teachers can register for MoonKAM and give their students the opportunity to take their own pictures of the Moon.

For more information about GRAIL, visit:

<http://www.nasa.gov/grail>

<http://grail.nasa.gov>

For more information about MoonKAM, visit:

<https://moonkam.ucsd.edu/>

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National Aeronautics and Space Administration

**Jet Propulsion Laboratory**  
California Institute of Technology  
Pasadena, California

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